# ANSI/ASHRAE/IESNA Standard 90.1


U.S. Department of Energy
Building Energy Codes Program

Produced by the Pacific Northwest National Laboratory

# Why is Standard 90.1 important?

- It replaces ANSI/ASHRAE/IESNA Standard 90.1-1989 and the codified version of Standard 90.1-1989 (the gray book)
- It is the reference standard for Chapter 7 of the 2001 IECC
- It is also the commercial energy reference in NFPA's family of codes

# How has it changed since 90.1-1989?

- Written in mandatory, enforceable language
- Contains true prescriptive path for envelope
- Mechanical and envelope sections heavily dependent on economic analysis
- Lighting section heavily dependent on lighting quality considerations
- Pays considerable more attention to existing buildings

# How has it changed?

- Does not include lighting tradeoff software (LTGSTD)
- Does include a simplified mechanical systems approach for “simple” buildings
- Does include separate envelope requirements for non-residential, residential, and semi-heated spaces
- Is accompanied by ASHRAE Guideline 18 (ways to go beyond Standard 90.1) – *in process*
- Extends scope and coverage (alterations and additions)
- Includes international units
- Expands climate locations
- Is reorganized for ease of use

# How is it the same?

- Contains separate envelope, HVAC, SWH, and lighting provisions
- Includes envelope tradeoff software (ENVSTD – new version)
- Contains an energy cost budget tradeoff method

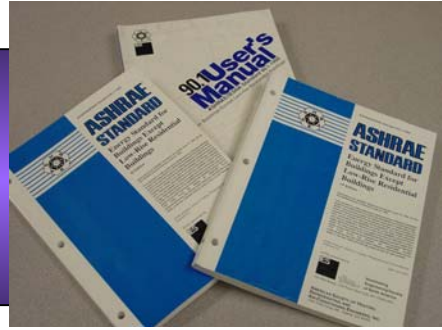
# How has stringency changed?

- Mechanical requirements generally more stringent (with exception of economizers)
- Envelope requirements a mixed bag – some more stringent, some less, depending on economics
- Lighting requirements generally more stringent with exception of some building types and space types

# How can I find out more about the differences?

- Excruciatingly detailed comparisons of Standards 90.1-1989 and 90.1-1999 may be found at http://www.energycodes.gov/implement/determinations_com.stm
- PNNL is also working on comparisons of the 90.1-1999 Standard and Chapter 8 of the 2001 IECC

# How can I get a copy?




- Standard 90.1, the Standard 90.1 Users Manual, and the ENVSTD software are available from ASHRAE

www.ashrae.org

404-636-8400

# Comparison of organization of sections of Standard 90.1

## 90.1-1989

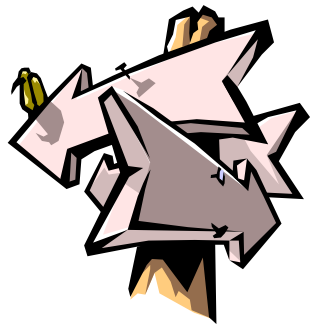
4 – Compliance
5 – Electric power
6 – Lighting
7 – Auxiliary systems and equipment
8 – Building Envelope
9 – HVAC Systems
10 – HVAC Equipment
11 – SWH
12 – Energy management
13 - ECB

## 90.1-1999

4 – Administration and enforcement
5 – Building envelope
6 – HVAC
7 – SWH
8 – Power
9 – Lighting
10 – Other equipment
11 - ECB

## 90.1-2001

Same as 90.1-1999 with the addition of Appendix F - Addenda



# Standard 90.1

Section 1 - Purpose

Section 2 - Scope

Section 3 - Definitions, Abbreviations, and Acronyms

Section 4 - Administration and Enforcement

Section 5 - Building Envelope

Section 6 - Heating, Ventilating, and Air-Conditioning

Section 7 - Service Water Heating

Section 8 - Power

# Standard 90.1

Section 9 - Lighting

Section 10 - Other Equipment

Section 11 - Energy Cost Budget Method

Section 12 - Normative References

Appendices A-D - Mostly envelope related

Appendix E - Informative References

Appendix F – Addenda Description Information

# Section 1 - Purpose

To provide minimum requirements for the energy-efficient design of buildings except low-rise residential buildings

# Section 2 - Scope

- New buildings and their systems
- New *portions* of buildings and their systems (additions)
- New systems and equipment in *existing* buildings (alterations)

# Section 2 – Scope *(cont'd)*

- Envelope
  - if heated by a heating system with an output capacity $3.4 btu/h-ft$^2$ or
  - if cooled by a cooling system with a sensible output $5 btu/h-ft$^2$
- Virtually all mechanical and lighting systems are covered

# Scope exceptions

- Too little heating or cooling
- Single-family, multifamily of three stories or less, manufactured or modular homes
- Buildings that don’t use electricity or fossil fuel
- Equipment and portions of building systems that use energy primarily for industrial, manufacturing, or commercial purposes

# Section 3 - Definitions, Abbreviations, and Acronyms

- Over 10 pages of definitions
- 1 page of abbreviations and acronyms
- Defined terms are italicized in text of standard

# Section 4 – Administration and Enforcement

- Specifies
  - what applies to new buildings, existing buildings, additions to existing buildings, alterations to existing buildings
  - exemptions for envelope, HVAC, SWH, power, lighting, and other equipment alterations
- Discusses changes in space conditioning

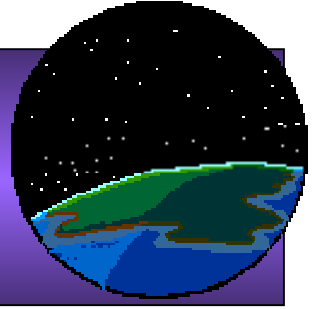
# Administration and Enforcement *(cont'd)*

- Addresses
  - compliance documentation
  - labeling of materials and equipment
  - fenestration, doors, insulation, mechanical equipment, and packaged terminal air conditioners
  - alternative materials and methods of construction
  - inspections

# Section 5 – Building Envelope

- General *(Section 5.1)*
  - Scope
  - Compliance
  - Climate
  - Space-Conditioning Categories and Basis
- Mandatory Provisions *(Section 5.2)*
  - Insulation
  - Fenestration and Doors
  - Air Leakage
- Prescriptive Building Envelope Option *(Section 5.3)*
  - Opaque Areas
  - Fenestration
- Building Envelope Trade-Off Options *(Section 5.4)*

# Scope *(Section 5.1.1)*



- Envelope components that enclose
  - Conditioned space
  - Semi-heated space
- Requirements apply to three types of spaces
  - Nonresidential
  - Residential
  - Semi-heated
- Exceptions

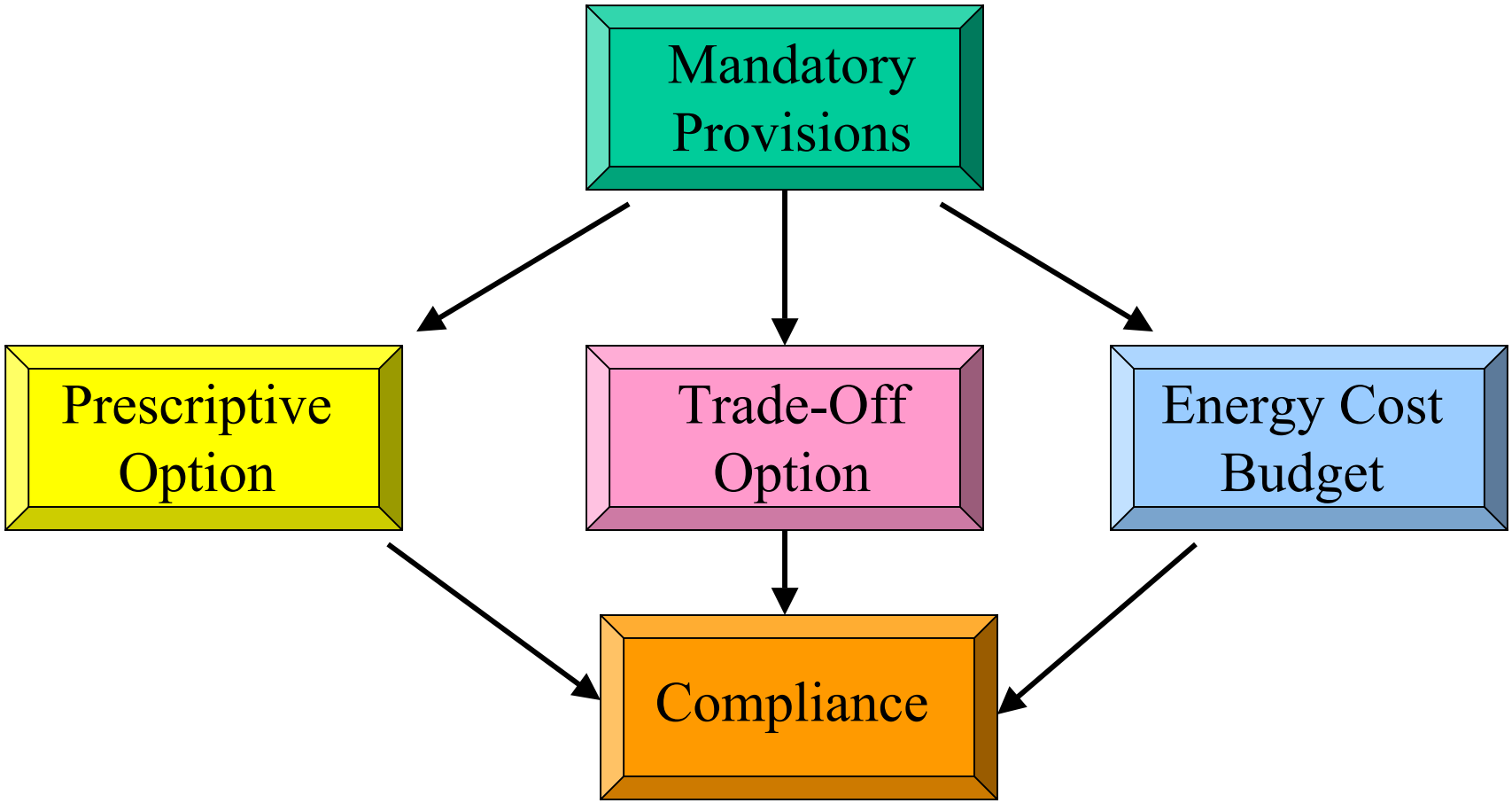
# Semi-heated space

- Has a heating system with a capacity > 3.4 Btu/h.ft$^2$ (10 W/m$^2$) of floor area but is not conditioned space

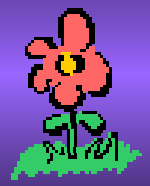
# Exceptions

- All semi-heated and unconditioned spaces to be clearly indicated on floors plans
- If space
  - is only semiheated, it shall be considered semi-heated
  - will remain unconditioned, it shall be considered unconditioned
- In climates > 1800 HDD65, space may be designated either semi-heated or unconditioned only if approved by the building official

# Envelope Compliance Methods *(Section 5.1.2)*



# Climate *(Section 5.1.3)*



- Bins based on CDD50 and HDD65
  - Locations listed in Appendix D
  - If location not listed, select one with "closest" climatic conditions

# CDD and HDD

- CDD50 = for any one day, when the mean temperature is > 50F, there are as many degree-days as degrees F temperature difference between mean temperature and 50F. Annual cooling degree days (CDD) are the sum of the degree-days over a calendar year.

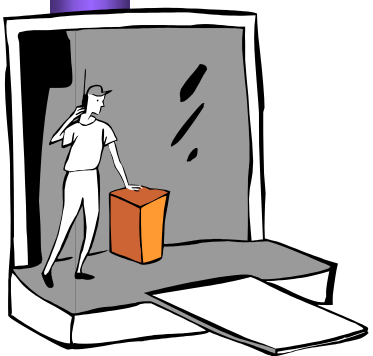
- HDD65 = for any one day, when the temperature is < 65F, there are as many degree-days as degrees F temperature difference between mean temperature and 65. Annual heating degree-days (HDD) are the sum of the degree-days over a calendar year.

# Space-Conditioning Categories and Basis Envelope Requirements Are Specified by Space-Conditioning Categories *(Section 5.1.4)*

- Each space to be included in a category
  - Nonresidential conditioned space
  - Residential conditioned space
  - Both nonresidential and residential semiheated space
- Spaces in climates > 1800 HDD65 assumed to be conditioned space unless
  - Space will only be semiheated or unconditioned and
  - Approved as such by the building official

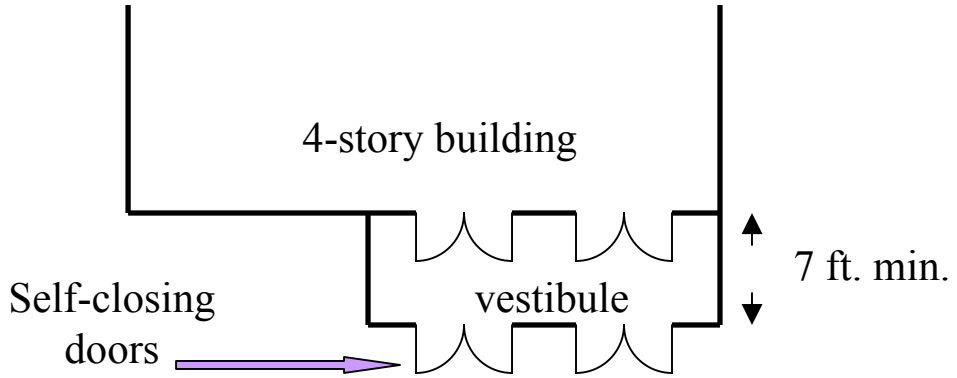
# Loading Dock Weatherseals
## *(Section 5.2.3.3) (Section 5.5.3.3)*

- > 3600 HDD65
  - Cargo doors and loading dock doors equipped with weatherseals
    - To restrict infiltration when vehicles are parked in the doorway



# Vestibules *(Section 5.2.3.4)* *(Section 5.5.3.4)*

- All exterior doors in tall buildings in cold climates must have a vestibule with
  - Self-closing doors
  - Interior and exterior doors must not be open at the same time
  - Distance between interior and exterior doors not < 7 ft when in closed position (remember ADA!)



# Vestibule exceptions

- Non-entrance doors (mechanical/electrical rooms)
- Vehicle and material handling doors and adjacent personnel doors **OR** revolving doors
- All doors in climates < 1800 HDD65 **OR** in buildings < 4 stories
- All doors that open into spaces < 3000 $ft^2$ **OR** into dwelling units

Envelope Prescriptive Option

# Opaque Doors *(Section 5.3.1.6)*

- Meet or exceed maximum U-factors in appropriate table in Appendix B

# Building Envelope Trade-Off Option *(Section 5.4)*

Trade-Off Option

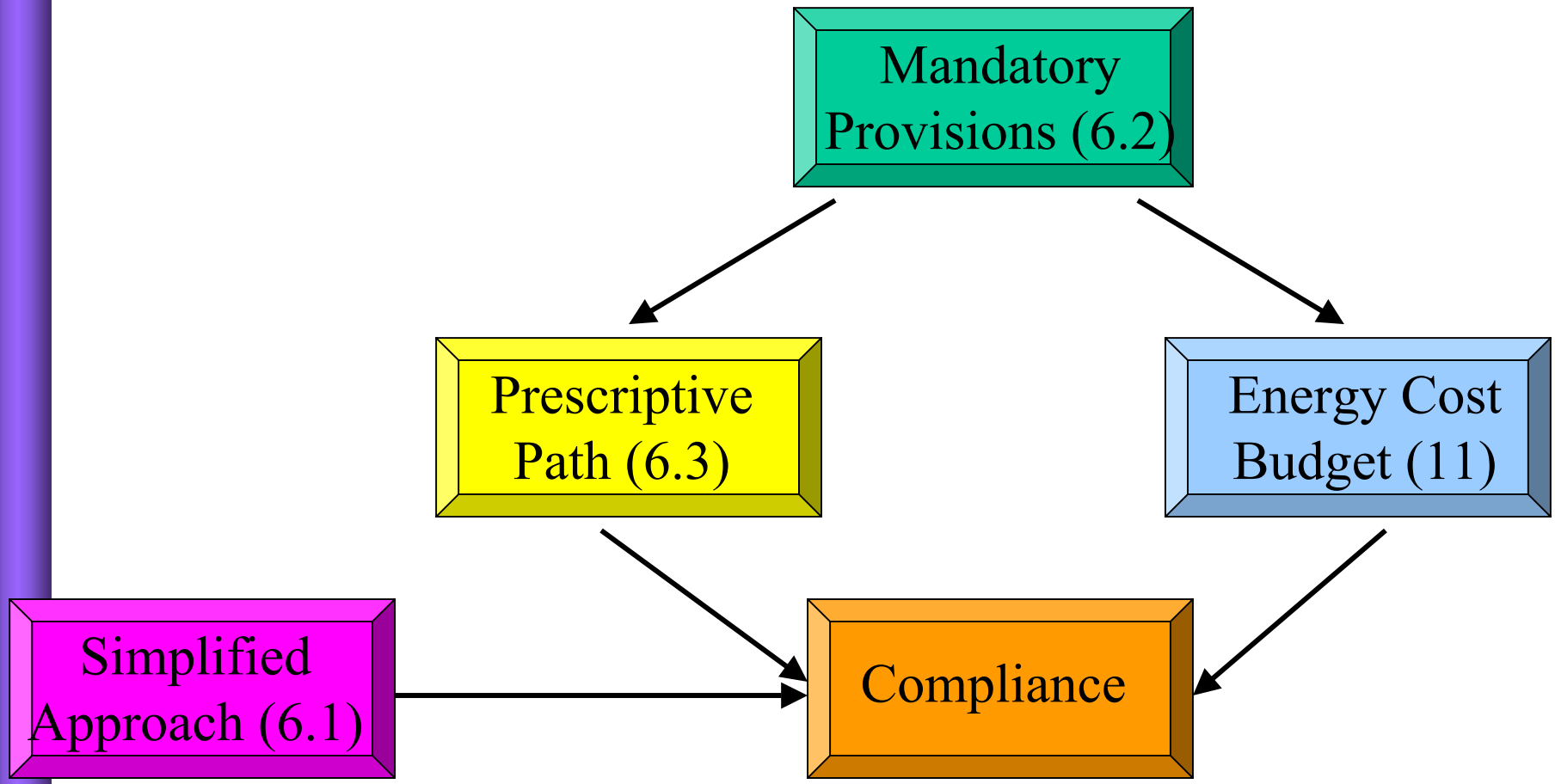
- Building complies if
  - It satisfies the provisions of 5.1 and 5.2
  - $\frac{\text{EPF}_{\text{Proposed Building}}}{\text{EPF}_{\text{Budget Building}}} \geq 1$

EPF = envelope performance factor

EPF is calculated using Normative Appendix C

*Schedules of operation, lighting power, equipment power, occupant density, and mechanical systems to be the same for proposed building and budget building*

# Section 6 - HVAC Compliance

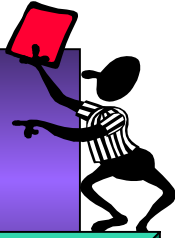


# Simplified Approach Option
*(Section 6.1)*

Simplified Approach

- Limited to…
  - Buildings with 1 or 2 stories
  - Buildings < 25,000ft$^2$
  - Single-zone systems
  - Air-cooled or evaporatively-cooled only

# HVAC Mandatory Provisions
*(Section 6.2)*




- Mechanical Equipment Efficiency *(Section 6.2.1)*
- Load Calculations *(Section 6.2.2)*
- Controls *(Section 6.2.3)*
- HVAC System Construction and Insulation (*Section 6.2.4)*
- Completion Requirements *(Section 6.2.5)*

*Required in both Prescriptive and ECB compliance paths*

# Equipment covered for the first time in 90.1-1999

- Ground-source heat pumps
- Single- and double-effect absorption chillers
- Heat rejection equipment
- New categories for
  - Hot water and steam boilers
  - Replacement PTACs and PTHPs

HVAC Mandatory Provisions/Controls

# Enclosed Parking Garage Ventilation *(Section 6.2.3.5) - Deleted*

- Garage ventilation fan systems with total design capacity > 30,000 cfm to have at least one automatic control
  - capable of staging fans or modulating fan volume as required to maintain CO levels below ASHRAE Standard 62 (only applies to garages used predominantly by gasoline-powered vehicles)
  - complying with 6.2.3.2.1 that's capable of shutting off fans or reducing fan volume during periods when garage is not in use

# Completion Requirements *(Section 6.2.5)*

- Record drawings
- Operating and maintenance manuals
- System balancing
- System commissioning

# Drawings
*(Section 6.2.5.1)*

- Record drawings of actual installation to building owner within 90 days of system acceptance and include, as a minimum
  - Location and performance data on each piece of equipment
  - General configuration of duct and pipe distribution system including sizes
  - Terminal air or water design flow rates

# Manuals *(Section 6.2.5.2)*

- Operating and maintenance manuals to building owner within 90 days of system acceptance and include, as a minimum

# System Commissioning *(Section 6.2.5.4)*

- Control elements are calibrated, adjusted, and in proper working condition
- > 50,000 $ft^2$ conditioned area
  - Except warehouses and semiheated spaces
  - Requires commissioning plan

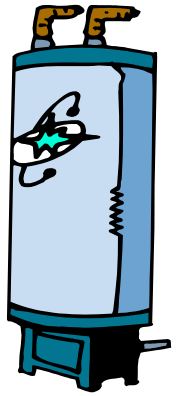
HVAC Prescriptive Path

# Radiant Heating Systems *(Section 6.3.8)*

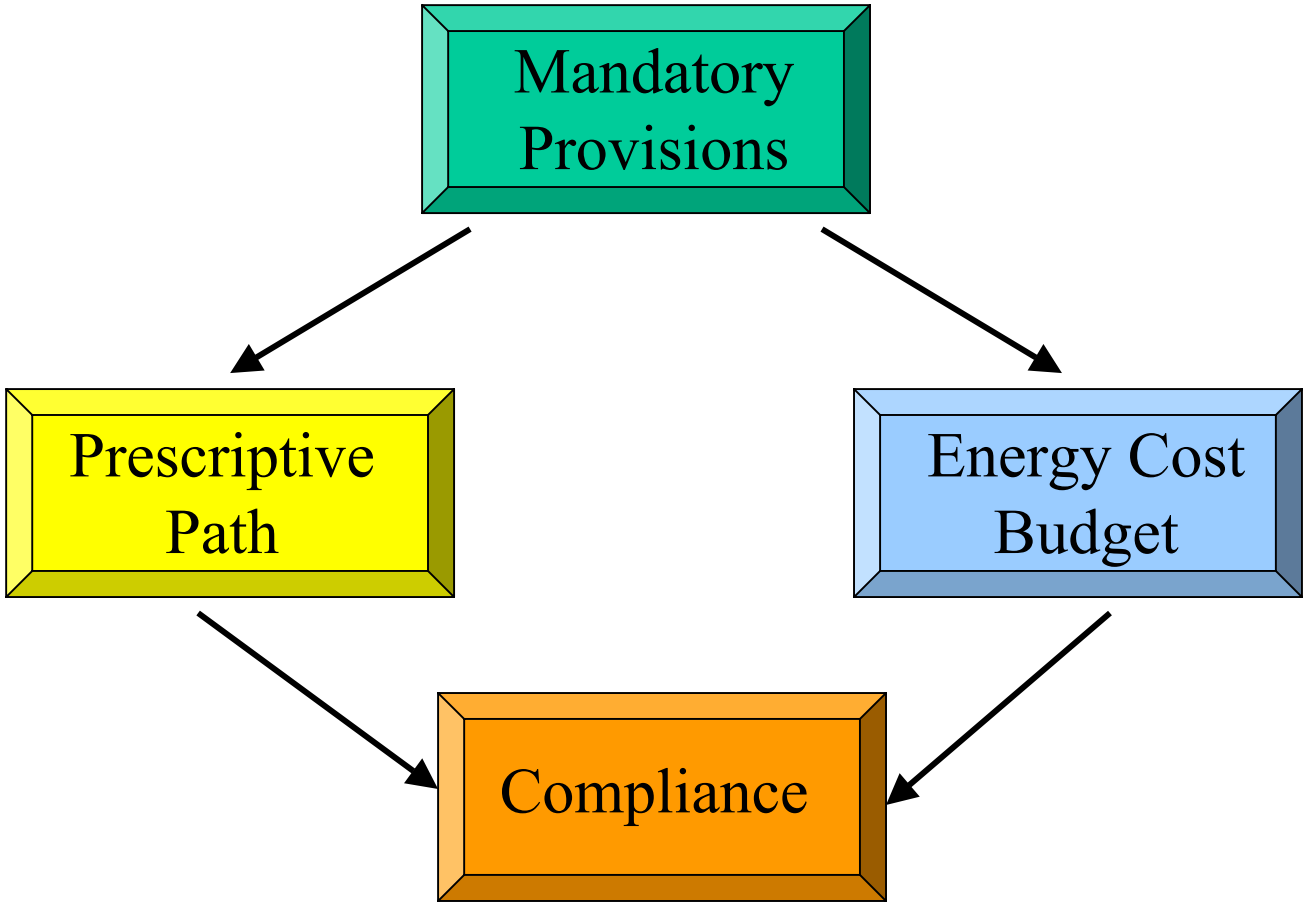
- Required for unenclosed spaces except loading docks with air curtains
- "Radiant heating systems that are used as primary or supplemental enclosed space heating must be in conformance with the governing provisions of the standard"

# Section 7 - Service Water Heating

- General *(Section 7.1)*
- Mandatory Provisions *(Section 7.2)*
  - Sizing of systems Load Calculations
  - Equipment efficiency
  - Service hot water piping insulation
  - System controls
  - Pools
  - Heat traps
  - Space heating and water heating
  - Service water heating equipment
- Prescriptive Path *(Section 7.3)*



# SWH Compliance *(Section 7.1.2)*



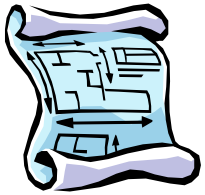
# Section 8 - Power

Mandatory Provisions

- Voltage drop
- Completion requirements

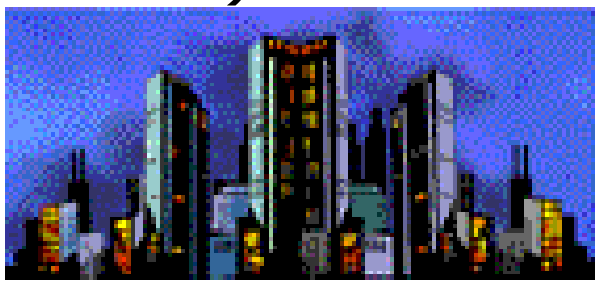
# Completion Requirements
*(Section 8.2.2)*

- Owner gets information about the building's electrical system
  - Record drawings of actual installation within 30 days
  - Manuals

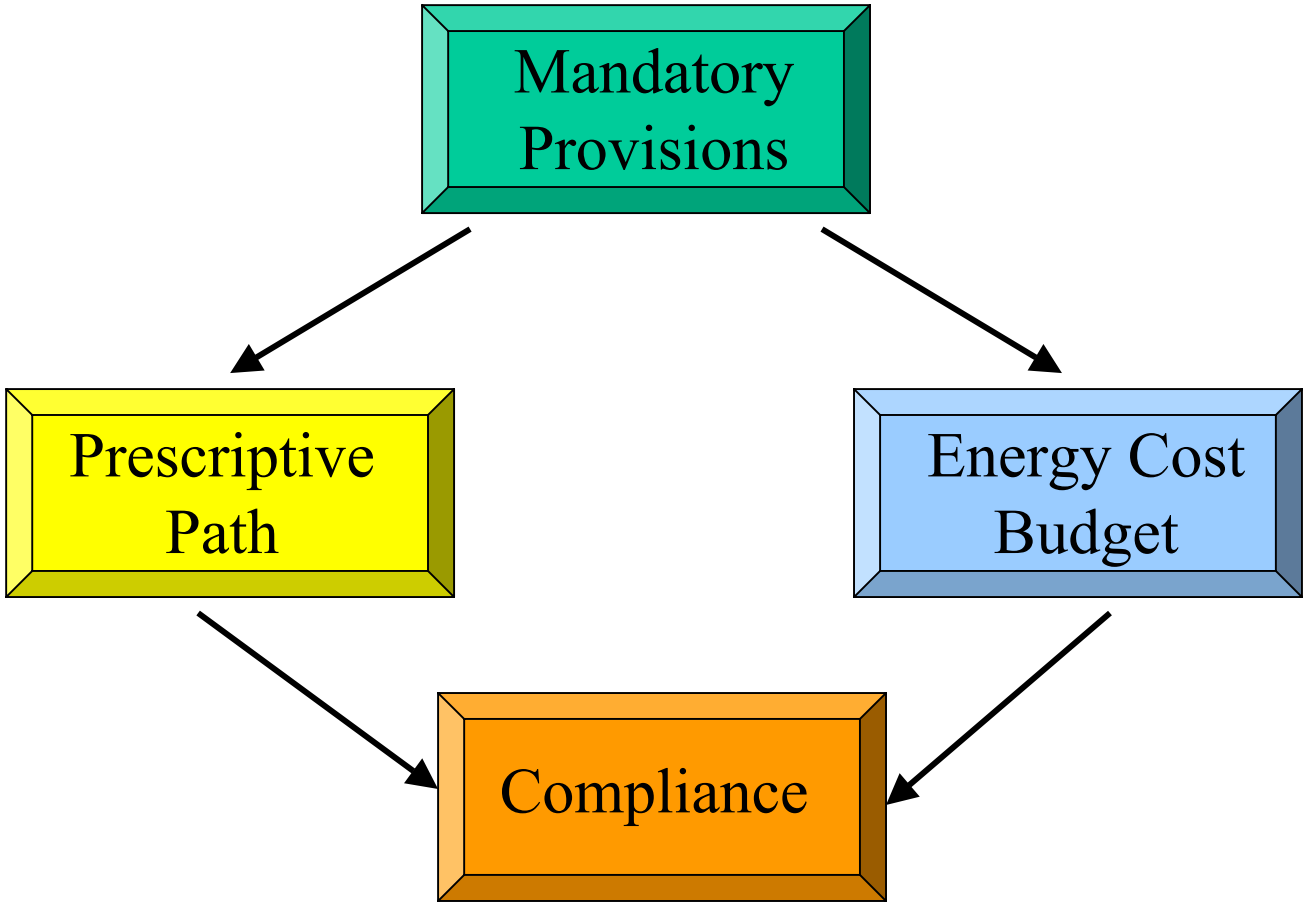


# Section 9 - Lighting

- General Application *(Section 9.1)*
- Mandatory Provisions *(Section 9.2)*
  - Lighting controls
  - Tandem wiring
  - Exit signs
  - Installed interior lighting power
  - Luminaire wattage
  - Exterior building grounds lighting
- Prescriptive Path *(Section 9.3)*
  - Interior Lighting Power Allowance
    - Building Area Method
    - Space-by-Space Method
  - Exterior Lighting Power Allowance



# Lighting compliance



# Lighting changes between 90.1-1989 and 90.1-2001

- More efficient lighting
  - Less power allowed
- No lighting control credits
  - Lighting power allowance now based only on connected lighting power
- No control points for spaces
- No separate lighting controls for daylighted spaces

# Lighting changes between 90.1-1989 and 90.1-2001 *(cont'd)*

- Automatic shutoff controls required
- Most exterior power requirements replaced with minimum efficacy requirements
  - Parking garages included in interior lighting
- Interior power requirements updated
  - More stringent requirements
  - Area factors no longer need to be calculated
  - Building area allowances no longer depend on size
- Additional power allowances for certain specialty lighting

# Lighting scope

- New construction
- Existing nonresidential and high-rise residential
  - If $ 50% of existing luminaires are replaced
  - If renovation increases lighting power
- Control devices can't control
  - > 2500 $ft^2$ in spaces < 10,000 $ft^2$
  - > 10,000 $ft^2$ in spaces > 10,000 $ft^2$
- Control must be readily accessible and located so occupants can see the controlled lighting

Lighting Mandatory Provisions

# Exit Signs *(Section 9.2.3)*


- Exit signs operating at > 20 W must have a source efficacy $ 35 lumens/W
- LED lamps okay
- CF lamps with electronic ballasts usually okay
- Majority of incandescent lamps not okay

# Lighting power development concept

- Create building space models to calculate power densities with:
  - Current product performance data
  - Updated efficacy and loss factors
  - New building construction data
  - IES-recommended light levels
  - Professional lighting design consensus

# Section 10 - Other Equipment

- Changes between 90.1-1989 and 90.1-1999
  - No transformer recommendations and requirements
  - No subdivision of electrical feeders or provisions for check metering
  - *Motor efficiency levels are higher and correspond to EPAct (only requirement in this section)*
  - Motor efficiency requirement now covers all relevant motors, even if they're part of equipment rated elsewhere in the Standard
  - No exemption for motors running < 1000 hrs/yr

# Section 11 - Energy Cost Budget Method

- The ultimate trade-off method allowing you to trade-off across building systems through the use of annual, hourly simulation tools and a baseline building.
- The only real way to deal with unique designs,  renewables, high-efficiency equipment, etc.
- The basis of the energy portion of the LEED rating
- Limits allowable energy costs of the design to those of a building meeting the Standard

# Section 12 - Normative References

- Normative (read “mandatory”) reference documents
- Includes test methods, rating procedures, and other standards

# Assembly U-Factor, C-Factor, and F-Factor Determination (Normative Appendix A)

- Includes pre-calculated U-factors, C-factors, and F-factors
  - Above-grade walls
  - Below-grade walls
  - Floors
  - Slab-on-grade floors
  - Opaque doors
  - Fenestration

# Building Envelope Criteria
## (Normative Appendix B)

- Actual prescriptive requirements tables for 26 different climate bins
- These are in an appendix because they would have taken up too much space in Chapter 5 and would have broken up the continuity of the text of the Standard

# Methodology for Building Envelope Trade-Off Option in Subsection 5.4 (Normative Appendix C)

- The gory details of how the envelope trade-off option is implemented
- For those familiar with the "old" ENVSTD trade-off, this new trade-off allows trade-offs between roof and wall elements. The "metric" of trade-off is ultimately an energy dollar trade-off.

# Climate Data
## (Normative Appendix D)

- Climatic data for a number of US, Canadian, and international locations
- HDD65 and CDD50 for use in envelope calculations
- Heating and cooling design temperatures and the old “number of hours between 8 am and 4 pm with Tdb between 55 and 69” for HVAC calculations

# Informative References
## (Informative Appendix E)

- Other useful references that are not mandatory
- In general, these are not consensus documents so ASHRAE procedures do not allow them to be mandatory references

# Informative References
## (Informative Appendix F)

- Information on addenda to 90.1-1999

# DOE Software

- Standard 90.1-1999 is included as an option in COM*check*-*EZ* Version 2.4 Release 1
  - Available for download at www.energycodes.gov

# More Training

- The ASHRAE Learning Institute offers a two-day professional development seminar on Standard 90.1
- Several organizations offer one-day training classes
- ASHRAE is planning a grass roots training program through their chapters as well